Hamilton - Wentworth Waste Management Study

Summary Report of Work to Date

Proctor & Redfern Limited
Consulting Engineers and Planners

REGIONAL MUNICIPALITY

OF

HAMILTON - WENTWORTH

WASTE MANAGEMENT STUDY

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PROJECT E.O. 72100

January 1974

I. INTRODUCTION

The first and second interim reports of the Hamilton-Wentworth Waste Management Study have been completed. A third document, providing the cost analysis for comparing the various systems proposed has also been completed.

The purpose of this report is to summarize the progress made to date.

The first interim report was concerned with the assembly of the data necessary to provide the basis for determining the quantity and composition of all solid wastes requiring collection and disposal over the next twenty years.

Included in the report was (i) analysis of population, employment, and land use trends in the area, (ii) a survey of existing waste management practices (iii) analysis of existing waste generation patterns of the residential, manufacturing, retail, service, and agricultural sectors, and (iv) terrain evaluation studies to evaluate present sanitary landfill operations and to determine which areas

might be suitable for new operations.

Subsequent to the completion of the first interim report of the Hamilton-Wentworth Waste Management Study, the final aspects of the Data Collection and Analysis Phase were completed involving observations and the recording of data at all of the waste disposal sites within the Study Area. From those data along with others derived from the first interim report, it has been possible to project the quantity and composition of solid waste materials likely to be generated in the Study Area by the years 1982 and 1992.

Those projections have provided the basis for examining alternative waste management systems available for the Study Area, and are displayed in Tables 1 to 7 in the Appendix.

A review of the components of a waste management system, and the alternative handling systems available led to a choice of three arrangements for more detailed study. The three systems, a regional, a modified regional, and a municipal have been costed for 1974 to show the relative economic advantages and disadvantages of each. These results must be viewed in relationship with other considerations such as desired level of service, cost of haul, site availability, and so on.

II. PROPOSALS FOR AN AREA-WIDE WASTE MANAGEMENT SYSTEM

A. Use of Projections Based on Generation Factors

The projected quantities of wastes displayed in the appendix are regarded to be reasonable, realistic upper limits in view of the fact that no allowance has been made for modifications to generation characteristics resulting from changes in packaging techniques, consumer purchasing and disposal habits, manufacturing processings, or governmental enactments resulting in the diminution of waste products. Nor do these calculations include allowance for the recovery of resources out of the total wastes for re-entry into the productive stream by recycling.

In view of the myriad of factors operating to influence the quantity and composition of solid waste materials, the approach has been taken that the design of a solid

waste management system capable of accommodating all the projected wastes and without allowance for the factors mentioned above, would ensure a system of adequate capacity to meet unanticipated increases in the quantities of solid waste materials resulting from the introduction of new products or manufacturing operations in the Hamilton-Wentworth area hitherto not contemplated.

B. Review of Processing Techniques

In recent years considerable research and experimentation has been undertaken into a variety of solid waste disposal techniques. In addition to the traditionally accepted methods of sanitary landfill and incineration, these investigations have included the following:

(i) Pyrolysis,

(ii) Composting,

(iii) Anaerobic digestion with sewage sludge,

(iv) Wet oxidation of organic wastes, and

(v) Biological fractionation of organic wastes.

In addition, attention has been focused on volume reduction of solid waste materials prior to their disposal by such methods as:

(i) Compaction,

(ii) Baling,

(iii) Grinding,

(iv) Shredding.

Finally, studies have led to the development of equipment to facilitate the mechanical or manual sorting or separation of solid waste materials to facilitate resource recovery programs as a necessary prelude to recycling of usable materials.

An extensive literature search and direct communication with the United States Environmental Protection Agency Office of Solid Waste Management Programs has indicated that all of the new techniques are currently in an experimental stage requiring considerably more data before firm conclusions can be reached pertaining to their advantages and disadvantages as well as their economic viability. It is therefore not possible at this time to recommend any of these techniques to be included as integral component parts of a comprehensive solid waste management system for the Hamilton-Wentworth area. The approach, therefore, that has been taken in formulating the recommendations herein has been to rely on the existing methods of disposal including incineration

and sanitary landfill within the broad framework of a waste management system that can most readily accommodate new technological advancements as these become available.

C. Determinants for an Area-Wide Waste Management System

There are several important determinants influencing the most appropriate waste management system for the Hamilton-Wentworth area. These include the new incinerator, the constraints imposed upon collection systems by the limited number of access routes crossing the Niagara Escarpment and the existing delineation of responsibilities for the collection and disposal of residential wastes by municipal initiative and non-residential wastes by the private sector.

In addition, there is the policy of the Waste Management Branch of the Ontario Ministry of the Environment to encourage the development of waste management systems for larger geographical areas rather than to continue the proliferation of a large number of separate independent systems for every municipal jurisdiction.

D. Objectives for an Area-Wide Waste Management System

Underlying the determination of the most appropriate waste management system for the Hamilton-Wentworth area, therefore, were the following basic objectives:

(i) To optimize the utilization of the new Hamilton incinerator,

(ii) To optimize collection procedures for all types of wastes with respect to total travel distances between sources of waste and ultimate disposal sites,

(iii) To delineate as clearly as possible the areas of municipal responsibility as distinct from those of the private sector,

(iv) To minimize the possibility of atmospheric, soils or water pollution by the disposal techniques chosen,

(v) To maximize the opportunities for resource recovery as a prelude to recycling of usable waste materials,

(vi) To ensure complete coverage of the entire Hamilton-Wentworth area, and

(vii) To ensure that the system is appropriate for the growth that is anticipated will occur over a period of time extending for not less than twenty years.

E. Approaches to System Design

Two primary approaches were considered in developing proposals. One was to develop a system derived primarily upon consideration of the constraints imposed by geography with particular reference to the limitations on accessibility between areas above and below the escarpment. The second was to consider possible procedures to overcome the natural physical limitations but based on the differentiation between types of wastes requiring collection and disposal

with reference to those falling into the three broad categories of residential, non-residential and municipal and bulk wastes.

By accepting the limitations imposed by geography only and assuming that all types of wastes will be disposed of together would result in a system in which the incinerator and possible landfill sites would be utilized for putrescible and non-putrescible wastes. The attention of the City of Hamilton has already been drawn to the problems that might be encountered at the incinerator by the delivery to it of certain bulk materials and many of the materials originating at non-residential establishments. Operation of the incinerator would undoubtedly be facilitated if it were utilized only for residential wastes excluding trash and bulky articles.

At sanitary landfill sites, conversely, the major problems arise out of the disposal of putrescible materials. These include the possible contamination of ground water supplies by leachate, the attraction of rodents, the production of methane gas, and the congregation of gulls and other birds.

For these reasons, it is likely that the optimum use of these two types of facilities would be achieved if the incinerator is used solely for residential wastes and putrescible wastes of non-residential establishments with sanitary landfill sites being used for the non-putrescible wastes of non-residential establishments along with bulk and municipal wastes.

A system based on this type of differentiation would permit the maximum opportunity for resource recovery because the techniques applicable for wastes with putrescible materials can be quite different from those without them. It will also permit the clearer demarcation of areas of responsibility of the public and private sectors in the area of waste management.

Investigations were therefore carried out for waste management systems for the Hamilton-Wentworth area including the following components:

(i) The incinerator enlarged as necessary,

(ii) A sanitary landfill site or sites, and

(iii) No,one or more transfer stations.

III. SUGGESTING THE ALTERNATIVES

A. Alternatives Available

On the basis of the analyses outlined in this report, it would appear that the most reasonable alternatives available for waste management systems for the Hamilton-Wentworth area would be based on the use of the new Hamilton incinerator along with one or two major sanitary land disposal sites with the differences arising out of the types of materials to be disposed of at each. In the one case, the incinerator and the sanitary landfill sites would be utilized for the disposal of all types of solid wastes organized primarily on a geographic basis to minimize travel times and distances from the sources of origin to the disposal location.

In the other instance, materials to be disposed of at the incinerator would include only those from residential uses and the putrescible wastes from non-residential establishments. This would result in the landfill sites being used exclusively for non-putrescible materials.

In either case, operations at the following existing disposal sites should be terminated as soon as possible:

(i) West Flamborough

(ii) Beverly

(iii) Glanford

(iv) Binbrook

(v) Saltfleet.

Provided that acceptable sanitary landfill practices are followed, the Dundas Site should be permitted to continue in operation only until urban development impinges more closely to its borders.

The existing Upper Ottawa Street site in the City of Hamilton and the existing site in the Township of Ancaster should both continue to remain in operation. Insofar as possible, both of these sites should be enlarged to provide between 300 and 500 acres of additional land for landfill purposes. In view of the proximity of urban development to the Upper Ottawa Street site, while major extensions to it should be attempted, they should be done so with a view to having a capacity at which operation will be terminated by about the year 1982 which is when urbanization is

expected to impinge directly on the existing site. For that reason it is recommended that the major portion of additional capacity be provided more remote from the area of urbanization anticipated over the next twenty years such as in the vicinity of the Binbrook Reservoir.

Major extensions may also be possible to the existing Ancaster disposal site but should this present difficulties a site readily accessible to the future extension of Highway 403 further to the south in the Township should be sought. Thus by 1982 the disposal facilities of the Hamilton-Wentworth Waste Management System will include the incinerator, a landfill site in the vicinity of the Binbrook Reservoir and a second consisting either of an enlargement to the existing Ancaster site or a new site in the Township further to the south.

B. Comparative Advantages of Alternatives

The alternatives available for the Hamilton-Wentworth Waste Management System resolved down to the role of the incinerator and the types of wastes to be disposed of there. On the one hand it would be used only for residential and putrescible non-residential wastes while on the other it would be used for wastes from any source provided that they were acceptable.

The advantages of using the incinerator for residential and putrescible non-residential wastes are as follows:

(i) This system is more conducive to efficient resource recovery for recycling purposes;

(ii) The incinerator can operate most efficiently with less stringent control required over the examination of materials received for disposal;

(iii) The likelihood of shutdowns arising out of inappropriate materials being accepted would be minimized;

(iv) Inter-municipal cost sharing agreements for its use and the systems used for charging would be simplified since all users would be municipal jurisdictions;

(v) This would open the possibility of contracting out the operation of the landfill sites to private enterprise so that the public sector would have to assume administrative and operating responsibilities of only one disposal facility resulting in the likelihood of lower administrative costs;

(vi) The elimination of the risks of the contamination of ground water sources by leachate, the production of methane or the attraction of vectors and birds arising out of the fact that landfill sites would be used only for non-putrescible materials;

(vii) The need for far less stringent locational requirements for the landfill sites arising out of the fact that putrescible materials would not be involved; and

(ix) The possibility that no public capital expenditures for operating equipment would be needed at the landfill sites in view of the fact that this responsibility could be assumed by private enterprise.

The disadvantages of using the incinerator only for residential and putrescible non-residential wastes are as follows:

(i) Greater land area would be required for landfill sites necessitating additional land acquisition costs;

(ii) Travel times to the incinerator from more remote residential areas may become excessive necessitating the establishment of special smaller collection areas or the use of larger collection vehicles;

(iii) Increases in the incinerator capacity at some future date with the necessary attendant costs become almost inevitable (but that date is likely to be beyond 1992);

(iv) A greater degree of inter-municipal cooperation and more complex agreements would be required; and

(v) The unit disposal costs for residential wastes are likely to be greater than existing costs where disposal and sanitary landfill sites presently takes place.

Where a system is based on disposal of wastes at sanitary landfill sites and the incinerator with the incinerator being used for all types of wastes, the advantages would be as follows:

(i) Travel distances for collection vehicles can be optimized more readily by the choice of disposal site;

(ii) Less land area would be required for sanitary landfill sites thereby necessitating lower land aquisition costs;

(iii) The need for the enlargement of incinerator capacity can be postponed indefinitely by sustaining its operation at a maximum optimum level and disposing of all additional wastes at sanitary landfill sites;

(iv) A lesser degree of inter-municipal collaboration is required with less complex inter-municipal agreements; and

(v) The increase in unit disposal costs would likely be less for those areas presently using sanitary landfill sites that would continue to do so.

The disadvantages of this approach are as follows:

(i) It is less conducive to efficient resource recovery;

(ii) It requires careful examination and selection of materials from differing sources at the incinerator prior to their disposal;

(iii) More complex systems for user charges would be necessary in view of the myriad of potential users;

(iv) It is less conducive to the possibility of the private operation of the landfill sites and therefore would likely involve more complex administrative mechanisms with attendant increases in administrative costs;

(v) There would be a greater likelihood of shutdowns of the incinerator arising out of the possibility of inappropriate materials getting into its mechanisms;

(vi) Much greater care would be required in the exercise of the sanitary landfill operations in order to minimize the risk of the contamination of ground water sources by leachate, the production of methane and the attraction of vectors and birds;

(vii) Capital expenditures would likely be required of public funds for materials handling equipment to operate the sanitary landfill sites; and

(viii) Greater restrictions would be imposed upon the selection of sites appropriate for sanitary landfill operations thereby minimizing the degree of choice.

IV. COSTING THE ALTERNATIVES

Three systems have been costed for the year 1974 to demonstrate the economic advantages and disadvantages of each.

System A is a regional system

All residential waste in the study area will be accepted by SWARU. All non-residential, municipal, and bulk waste would be disposed of a two landfill sites which, for the purpose of the analysis, are assumed to be in the Townships of Ancaster and Glanbrook. A transfer facility is included in this scheme.

System B is a modified regional system

System B assumes that there will be three disposal areas: (i) in the western part of the area - possibly the Ancaster site, (ii) in the eastern part serving Stoney Creek and Glanbrook, and (iii) a site to serve the City of Hamilton.

System C is a municipal system

System C assumes that present operations will continue.

Chart I on Page A11 of the Appendix shows the cumulative wastes to 1992 that must be handled by a waste management system for Hamilton-Wentworth. This chart represents graphically the information presented in Table 7.

Chart II on Page A12 of the Appendix shows the distribution of these wastes among the various disposal areas in System A.

Table 11 shows the comparative disposal costs of the three systems. The cost per ton figures are:

System A at $1.46/ton
System B at $1.66/ton
System C at $1.78/ton

The figures shown in this summary table incorporate capital costs for site development such as access roads, site buildings, scales, monitoring wells, light, power, sanitary facilities, and engineering and contingencies. These costs are amortized over 20 years at 8%. Capital costs for equipment have been rated over 8 years at 8%.

Operational costs include the cost of site men, machine operators, vehicle operation and maintenance, and the cost of on site roads.

Costs of operating the Hamilton S.W.A.R.U. have not been included in these calculations as actual costs are not known as yet.

Although, at first glance, System A might be selected as the most attractive cost-wise, consideration must be given to the additional cost of hauling the waste to the major central sites as opposed to disposing of them locally. Desired level of service and availability of land are also important criteria to be considered when evaluating these different systems.

APPENDIX

TABLE NO. 1: ESTIMATED ANNUAL SOLID WASTES FOR STUDY AREA EXCLUDING WATERDOWN AND WEST FLAMBOROUGH UTILIZING 1972 GENERATION FACTORS

Type of Waste		Generation Factor Lbs/Person or Employee Per Annum	Persons or Employees	Estimated Solid Wastes Lbs.
Residential		600	394,600	236,760,000
Non-Residential				
Manufacturing		6,240	78,260	488,342,400
Retail		1,040	22,880	23,795,200
Service		2,080	37,465	77,927,200
Other		3,120	7,005	21,855,600
TOTAL	(Lbs.)	--	--	848,680,400
	(Tons)	--	--	424,340

TABLE NO. 2: SUMMARY OF SOLID WASTES
DEPOSITED AT DISPOSAL SITES DURING WEEK OF JUNE 12 - 19, 1972
INCLUDING PROJECTED ANNUAL TOTALS

Types of Waste	Packer Cu Yd.	Non-Packer Cu Yd.	Lbs/ Cu Yd.	Total Lbs.	Projected Annual Total Factor	Lbs.	Tons
1. Residential							
a). Packer	2,091		525	1,097,775	52	57,084,300	28,542
b). Non-Packer		3,459	200	691,800	52	35,973,600	17,987
c). City of Hamilton Vehicles				4,294,500	52	223,314,000	111,657
2. Non-Residential							
a). Packer	2,570		1,250	3,212,500	52	167,050,000	83,525
b). Non-Packer		9,183	600	5,509,800	52	286,509,600	143,255
Sub-Total	4,661	12,642	--	14,806,375	--	769,931,500	384,966
3. Construction Debris		12,524	1,620	20,288,880	40	811,555,200	405,778
4. Tree Clippings		2,691	270	726,570	30	21,797,100	10,899
5. Tires		60	400	24,000	52	1,248,000	624
6. Bulky Articles							
a). Packer	79		420	33,180	52	1,725,360	863
b). Non-Packer		6,710	140	939,400	52	48,848,800	24,424
7. Earth Fill		5,042	2,565	12,932,730	20	258,654,600	129,327
8. Asphalt, Rock, etc.		435	2,754	1,197,990	40	47,919,600	23,960
9. Wood Products		2,724	675	1,838,700	52	95,612,400	47,806
10. Catchbasin Sludge		20	2,300	46,000	8	368,000	184
11. Paper Boxes		57	120	6,840	52	355,680	178
12. Street Cleaning Dirt							
a). Packer	85		2,700	229,500	30	6,885,000	3,442
b). Non-Packer		256	2,300	588,800	30	17,664,000	8,832
Sub-Total	164	30,519	--	38,852,590	--	1,312,633,740	656,317
GRAND TOTAL	4,825	43,161	--	53,658,965	--	2,082,565,240	1,041,283

TABLE NO. 3: CHANGE IN PER CAPITA RESIDENTIAL SOLID WASTE GENERATION FACTORS 1962 - 1972

Year	Total Solid Wastes (Tons	Population	Waste Per Capita	% Change Per Annum
1962	80,135	269,459	595	
				.48
1963	81,860	273,935	598	
				2.16
1964	84,828	277,847	611	
				1.00
1965	85,575	283,099	605	
				3.59
1966	89,453	285,649	626	
				1.81
1967	92,952	291,536	637	
				4.59
1968	97,847	293,397	667	
				.19
1969	98,808	296,826	666	
				2.61
1970	101,407	296,857	683	
				2.03
1971	105,102	301,530	697	

- AVERAGE ANNUAL % CHANGE - 1.8%

TABLE NO. 4: SOLID WASTE GENERATION FACTORS FOR PROJECTION PURPOSES

Type of Waste	Generation Factor lbs/person or employee/annum		
	1972	1982	1992
1. Residential	600	720	860
2. Non-Residential			
a). Manufacturing	6,240	8,320	11,090
b). Retail	1,040	1,040	1,040
c). Service	2,080	2,080	2,080
d). Other	3,120	4,160	5,540

TABLE NO. 5: PROJECTION OF SOLID WASTES FOR THE HAMILTON-WENTWORTH AREA FOR THE YEARS 1972, 1982, AND 1992

Type of Waste	Projected Total Tonnage		
	1972	1982	1992
Residential	121,080	192,312	302,763
Non-Residential	308,454	540,794	886,871
Municipal and Bulk Wastes	656,317	868,307	1,114,428
TOTAL	1,085,851	1,601,413	2,304,062

TABLE NO. 6: CUMULATIVE QUANTITIES OF SOLID WASTE BY TYPE

Type of Waste	Cumulative Quantity (Tons)		
	1972 - 1982	1982 - 1992	1972 - 1992
Residential	1,723,656	2,722,912	4,446,568
Non-Residential	4,670,864	7,852,157	12,523,021
Municipal and Bulk Wastes	8,385,432	10,905,042	19,290,474
TOTAL	14,779,952	21,480,111	36,260,063

TABLE NO. 7: PROJECTED SANITARY LANDFILL REQUIREMENTS IN RELATION TO EXISTING INCINERATOR CAPACITY

	Cumulative Waste for Time Intervals		
	1972 - 1982	1982 - 1992	1972 - 1992
All Wastes	14,779,952 tons	21,480,111 tons	36,260,063 tons
Incinerator Capacity as existing @ 210,000 tons/year	2,100,000	2,100,000	4,200,000
Wastes to be disposed of at Landfill Sites:			
a) Residential*	-	622,912 tons	246,568 tons
Total cu. yds. @ 500 lb./cu.yd.	-	2,491,648 cu.yd.	986,272 cu.yd.
Area required @ 20,000 cu.yd./ 12 ft. lift acre	-	10.4 acres	4.1 acres
Area required assuming 6 lifts	-	1.7 acres	0.7 acres
b) Non-Residential*	4,294,520 tons	7,852,157 tons	12,523,021 tons
Total cu.yds. @ 750 lb./cu.yd.	11,372,053 cu. yd.	20,939,085 cu. yd.	33,394,723 cu. yd.
Area required for 12 ft. lift	47.4 acres	87.2 acres	139.1 acres
Area required for 6 lifts	7.9 acres	14.5 acres	23.2 acres
c) Municipal and Bulk*	8,385,432 tons	10,905,042 tons	19,290,474 tons
Total Cu. Yd. @ 1,275 lb.	13,153,619 cu. yd.	17,105,948 cu. yd.	30,259,567 cu. yd.
Area required for 12 ft. lift	658 acres	855 acres	1,513 acres
Area required for 6 lifts	110 acres	143 acres	253 acres
Total Landfill Site Requirements	117.9 acres	159.2 acres	276.9 acres

* Note: It has been assumed that the available incinerator capacity would be used for the disposal of residential wastes as projected in Table No. 6 and that any residual capacity would be used for non-residential wastes but that none of the municipal and bulk wastes would be disposed of at the incinerator.

TABLE NO. 8: PROJECTED SANITARY LANDFILL REQUIREMENTS
ASSUMING DOUBLING OF INCINERATOR CAPACITY IN 1982

	Cumulative Waste for Time Intervals		
	1972 - 1982	1982 - 1992	1972 - 1992
All Wastes	14,779,952 tons	21,480,111 tons	36,260,063 tons
Incinerator capacity @ 210,000 tons/year to 1982 @ 420,000 tons/year after 1982	2,100,000	4,200,000	6,300,000
Wastes to be disposed of at landfill sites			
a) Non-Residential	4,294,520 tons	6,375,064 tons	10,669,589 tons
Total cu.yds. @ 750 lb./cu.yd.	11,372,053 cu. yd.	17,000,171 cu. yd.	28,452,237 cu. yd.
Area required for 12 ft. lift	47.4 acres	70.8 acres	118.6 acres
Area required for 6 lifts	7.9 acres	11.8 acres	19.8 acres
b) Municipal and Bulk	8,385,432 tons	10,905,042 tons	19,290,474 tons
Total Cu. yds. @ 1,275 lb.	13,153,619 cu. yd.	17,105,948 cu. yd.	30,259,567 cu. yd.
Area required for 12 ft. lift	658 acres	855 acres	1,513 acres
Area required for 6 lifts	110 acres	143 acres	253 acres
Total Landfill Site Requirements	117.9 acres	154.8 acres	272.8 acres

TABLE NO. 9: PROJECTED INCINERATOR CAPACITY REQUIREMENTS ASSUMING ITS USE ONLY FOR RESIDENTIAL AND PUTRESCIBLE NON-RESIDENTIAL WASTES

Type of Wastes	Cumulative Waste (Tons) For Time Intervals		
	1972 - 1982	1982 - 1992	1972 - 1992
Residential	1,723,656	2,722,912	4,446,568
Putrescible Non-Residential Wastes*	124,508	205,723	330,231
TOTAL	1,848,164	2,928,635	4,776,799
Incinerator Capacity @ 210,000 Tons/Year	2,100,000	2,100,000	4,200,000
Additional Incinerator Capacity Required	-	828,635	576,799

* Putrescible non-residential wastes were determined by deducting from the projected cumulative totals of non-residential wastes in Table 6 the percentages indicated are 'fruit, vegetable, food and animal carcasses' in the tabulation on Page C-4 of Appendix 'C' of the First Interim Report. These percentages are: Manufacturing - 5%; Retail - 6%; Service - 8%; and Other - 4%.

TABLE NO. 10: PROJECTED SANITARY LANDFILL REQUIREMENTS FOR OTHER THAN RESIDENTIAL AND PUTRESCIBLE NON-RESIDENTIAL WASTES

	Cumulative Quantities for Time Intervals		
	1972 - 1982	1982 - 1992	1972 - 1992
1. Non-Putrescible Non-Residential Wastes	4,546,356 tons	7,646,534 tons	12,192,890 tons
Total Cu.Yds. @ 750 lbs/cu yd.*	12,123,616 cu. yd.	20,390,757 cu. yd.	32,514,373 cu. yd.
Area required @ 20,000 cu. yd/ 12' lift-acre	606 acres	1,019 acres	1,625 acres
Area required assuming 6 lifts	101 acres	170 acres	271 acres
2. Municipal and Bulk Wastes	8,385,432 tons	10,905,042 tons	19,290,474 tons
Total cu.yds. @ 1275 lbs/cu yd.*	13,153,619 cu. yd.	17,105,948 cu. yd.	30,259,567 cu. yd.
Area required @ 20,000 cu. yd/ 12' lift-acre	658 acres	855 acres	1,513 acres
Area required assuming 6 lifts	110 acres	143 acres	253 acres
Total Sanitary Landfill Site Requirements	211 acres	313 acres	524 acres

* These conversion factors were derived from the data available in Table 2 herein.

TABLE NO. 11:

1974

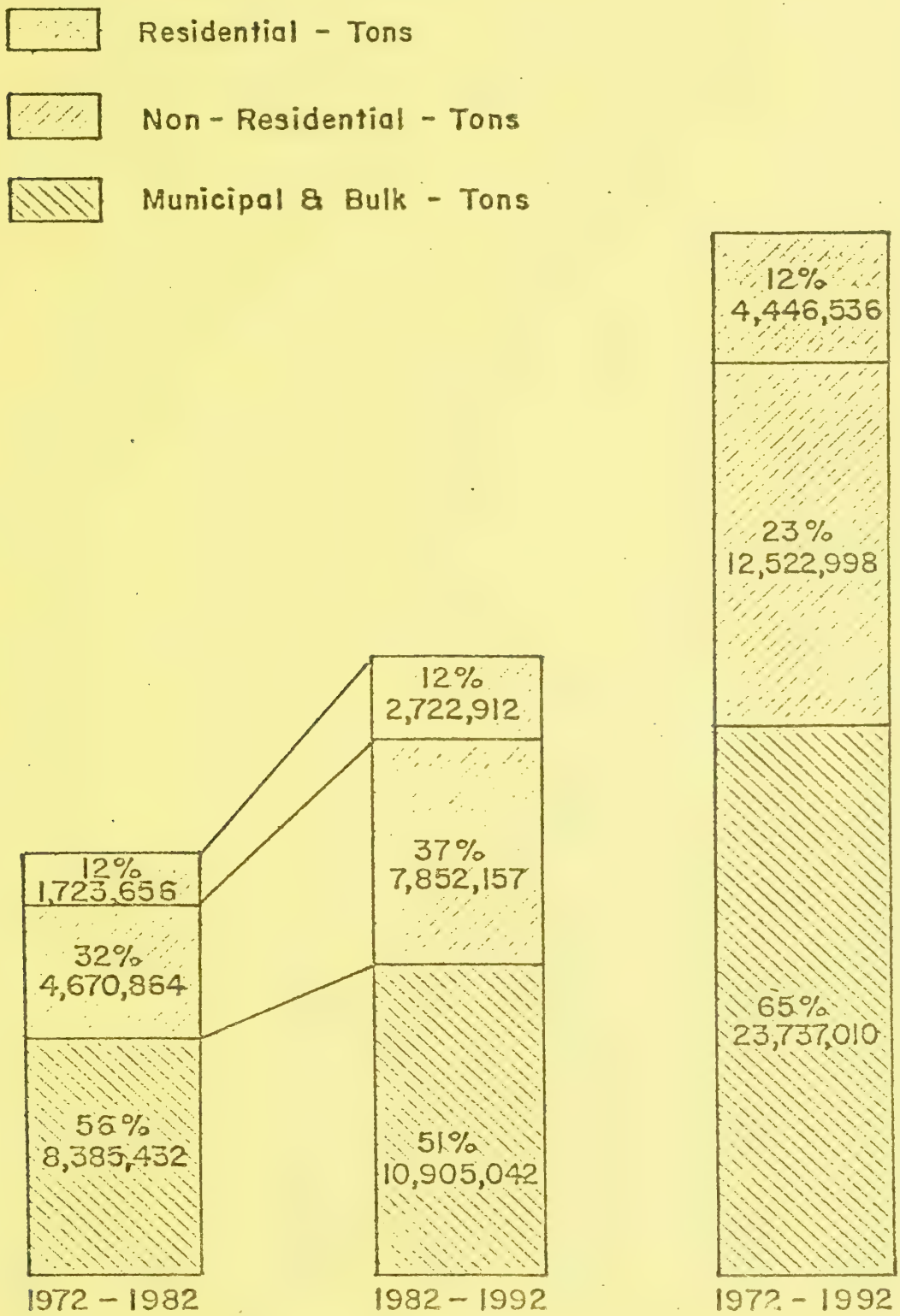
COMPARATIVE COSTS - SUMMARY (Excluding SWARU)

	Capital Costs excluding land	Annual * Cost of Operation	Cost per Ton	Land Cost per Ton
SYSTEM 'A'				
Ancaster Site	$ 403,000.	$ 334,879.	$ 2.92	$ 0.11
Glanbrook Site	$1,168,000.	$1,103,008.	$ 1.13	$ 0.03
Transfer Site	$ 563,600	$ 157,838.	$ 1.75	
	$2,179,109.	$1,595,725.		
	Total Tonnage 1,090,276		$ 1.46 average/ton	
SYSTEM 'B'				
Ancaster Site	$ 371,800.	$ 353,800.	$ 2.73	$ 0.03
Glanbrook Site	$ 373,600.	$ 344,100.	$ 3.15	$ 0.03
Hamilton Site	$1,153,000.	$1,157,380.	$ 1.31	$ 0.04
	$1,986,400.	$1,855,280.		
	Total Tonnage 1,120,598		$ 1.66 average/ton	
SYSTEM 'C'				
Hamilton Site	$1,153,000.	$1,156,340	$ 1.31	$ 0.04
Dundas Site	$ 171,400.	$ 148,249.	$ 3.27	$ 0.05
Stoney Creek Site	$ 297,000.	$ 281,590.	$ 3.36	$ 0.07
Ancaster Site	$ 190,400.	$ 126,345.	$ 4.63	$ 0.09
Flamborough Site	$ 202,400.	$ 160,069.	$ 2.84	$ 0.05
Glanbrook Site	$ 183,200.	$ 123,793.	$ 4.82	$ 0.06
	$2,197,400.	$1,996,386		
	Total Tonnage 1,120,598		$1.78 average/ton	

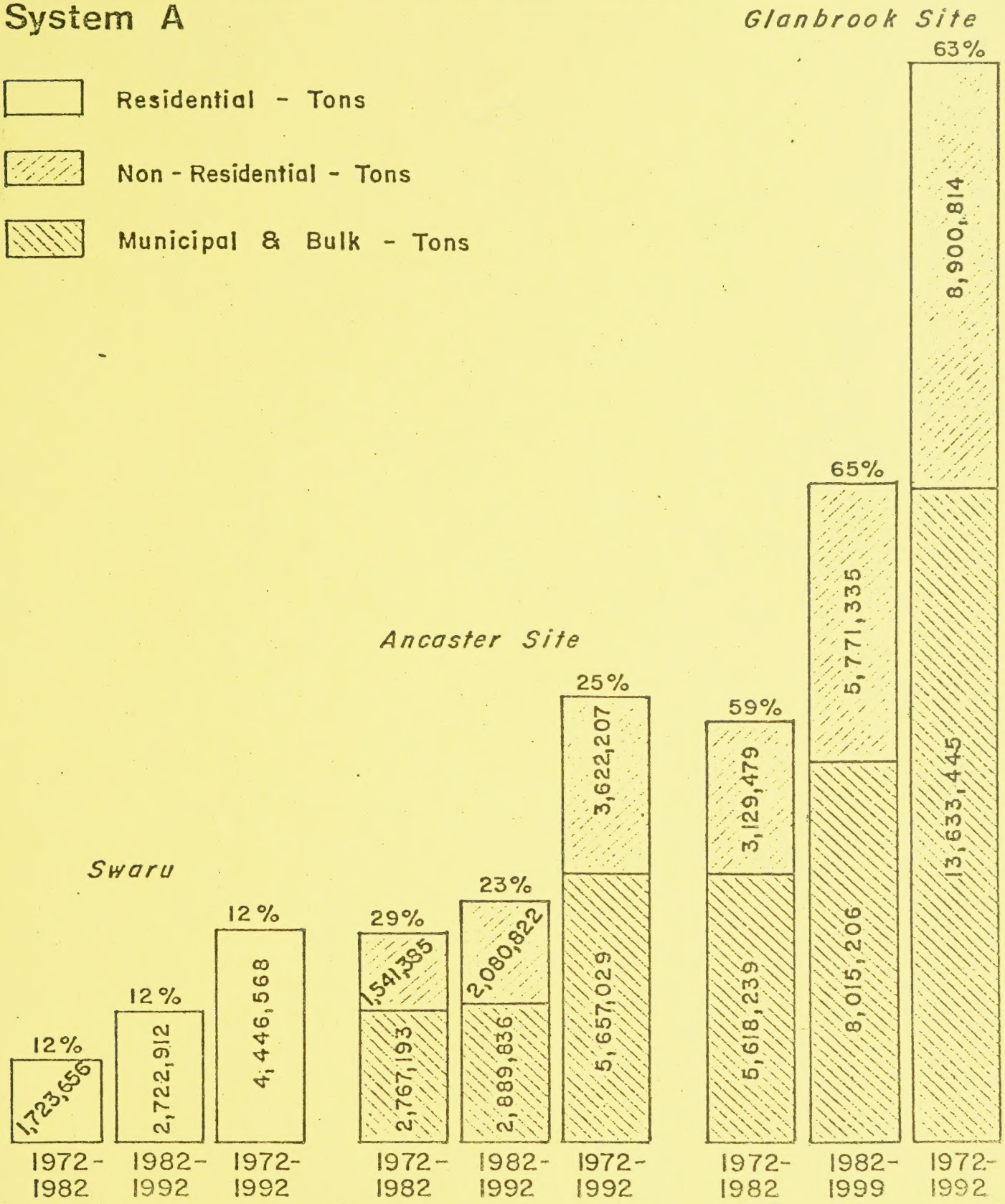
* Annual operating costs include Annual Operating Costs and Annual Capital Costs.

** Land costs are not included in cost per ton.

Hamilton - Wentworth Waste Management Study
Cumulative Wastes by Planning Periods
System A



Hamilton - Wentworth Waste Management Study
Cumulative Wastes to Disposal Areas
System A



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